MRI Approaches for Determination of Liver Iron Content – a Comparison

Arthur Wunderlich[1], Holger Cario[2], and Markus Juchems[1]
[1]*Diagnostic and Interventional Radiology, Univ.-Clinic Ulm, Ulm, Baden-Württemberg, Germany,* [2]*Childrens Hospital, Univ.-Clinic Ulm, Ulm, Baden-Württemberg, Germany*

Purpose. Compare established MR methods based on Spin-Echo (SE) vs. Gradient-Echo (GRE) to quantify liver iron content (LIC).

Methods. 198 patients (age 2 … 88 years, mean age 28,9 y) suspected for liver iron overload were examined by MRI to evaluate the amount of LIC. All examinations were performed at 1.5 T. Gradient echo sequences were acquired according to the protocol published by Alustizia et al [1] (further referenced as GRE1), a similar method proposed by Gandon et al [2] (further called GRE2) and a protocol designed to address higher LIC by Rose et al. [3] (GRE3). Furthermore, examinations with spin echo (SE) were performed with a protocol proposed by St. Pierre et al. [4]. For evaluation of GRE data, signal values are measured in manually drawn circular regions of interest (ROIs) in vessel-free parts of the liver and in the paraspinal muscles. Calculating the ratio of muscle reference value and liver signal, LIC was estimated according to [1-3]. If GRE1 yielded an LIC value of more than 180 µmol/g, GRE2 was used up to values of 300 µmol/g. If GRE2 exceeded this limit, GRE3 was used. Spin echo data was analyzed using a more sophisticated method [ref. 3 and references cited there] based on calculation of T_2 relaxation time. For each patient, LIC values were compared. The SE methods has an upper limit of 769 mmol/kg liver dry tissue, so patients with values of more than 750 µmol/g determined from SE data were excluded from analysis. Correlation between all GRE methods vs. SE was determined, as well as GRE1 in its coverage vs. SE.

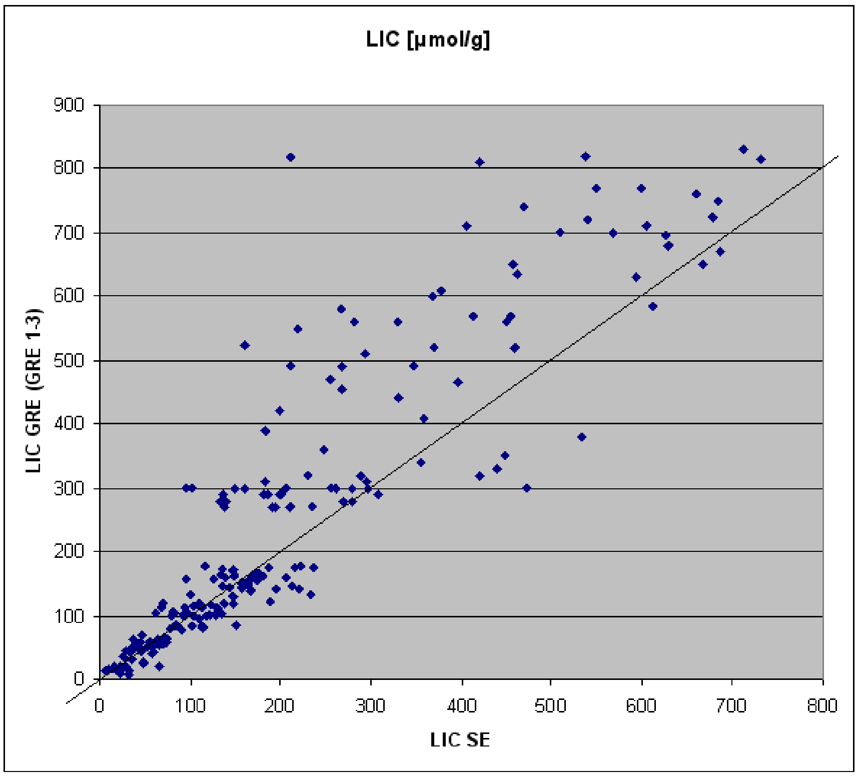

Fig. 1. Liver iron content in µmol/g liver dry tissue determined with GRE vs. SE. The solid line, which is the bisector, indicates identical results for both methods.

Results. GRE correlates reasonably with SE yielding a correlation coefficient of r=0.90. In the low LIC range, GRE1 performs alike with r=0.89. However, there is a mismatch between data: for patients closely above the upper limit of 180 µmol/g chosen for GRE1, GRE2 yields values of more than 270 µmol/g. Nearly all dots in Fig. 1 are located above the bisector line; therefore, GRE tends to overestimate LIC.

Discussion.. Although SE and GRE address different aspects of hepatic iron overload, a reasonably agreement was achieved by using different methods for determining LIC from GRE protocols.
The previously reported [5] inconsistence between results of GRE2 and SE were resolved by using the relation published by Alustizia [1] which performs good for low LIC values. Despite the gap in the results of GRE1 and GRE2, the correlation between results gained with both methods was good.

The SE method requires a long measurement time of 16 minutes as well as external referencing whereas GRE can be done in a few breathhold acquisitions with paraspinal muscles as internal reference and therefore is more easily accessible in every days routine.

It can be stated that both methods are suitable for a rough estimation of LIC and to differentiate between mild (up to 90 µmol/g) on the one hand and moderate or severe liver iron overload on the other for most of our patients which is of interest for disease management. Initial therapy success can be satisfactory monitored with the appropriate protocol. In general, GRE tends to overestimate LIC.

References. 1. J. Alustizia et al. MR Quantification of Hepatic Iron Concentration. Radiology 2004; 230:479–484
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5. A. Wunderlich et al.: Estimation of Liver Iron Content with different MRI methods. Proc. 17th ISMRM (2010), 4657